

AD-A131 568

A COMPARISON OF THE PROPHET AND ACOL FORCE PROJECTION
MODELS(U) CENTER FOR NAVAL ANALYSES ALEXANDRIA VA NAVAL
STUDIES GROUP M S GOLDBERG ET AL. JUN 81 CNA-PP-384

1/1

UNCLASSIFIED

N00014-76-C-0001

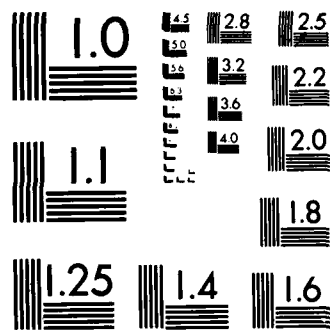
F/G 579

NL

END

FILMED

16



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

2

A COMPARISON OF THE PROPHET AND ACOL FORCE PROJECTION MODELS

Matthew S. Goldberg
Michael F. Hager

N00014-76-C-0001

ADA131560

DTIC FILE COPY



CENTER FOR NAVAL ANALYSES

83 08 11 063

PROFESSIONAL PAPER 384 June 1981

A COMPARISON OF THE PROPHET AND ACOL FORCE PROJECTION MODELS

Matthew S. Goldberg
Michael F. Hager



Naval Studies Group

CENTER FOR NAVAL ANALYSES

2000 North Beauregard Street, Alexandria, Virginia 22311

TABLE OF CONTENTS

	<u>Page</u>
List of tables	ii
Abstract	iii
Introduction	1
Description of the models	1
Retention behavior, FY 78-FY 80	2
Projections of the PROPHET model	6
Projections of the ACOL model	9
Comparisons of PROPHET and ACOL projections	11
Refining the ACOL projections	16
Revised ACOL projections	18
Conclusions	26
References	28



Letter in jacket

A

LIST OF TABLES

<u>Table</u>		<u>Page</u>
1	Historical endstrength	3
2	Historical reenlistment rates	4
3	Historical fractions of expired obligations	5
4	Input into ACOL model	7
5	PROPHET projections of expired obligations	8
6	PROPHET projections of endstrength	10
7	ACOL projections of reenlistment rates	12
8	ACOL projections of endstrength, using FY 77 expired obligations	13
9	ACOL projections of endstrength, using PROPHET projected expired obligations	14
10	Summary of career force projections	15
11	Data for revised ACOL projections	20
12	ACOL reenlistment rates using lagged bonuses	21
13	ACOL force levels using lagged bonuses	22
14	ACOL reenlistment rates using lagged bonuses and civilian unemployment	23
15	ACOL force levels using lagged bonuses and civilian unemployment	24
16	Summary of revised ACOL projections	25

ABSTRACT

We compared the projections of the PROPHET and ACOL models to historical experience over the period FY 78 - FY 80. The PROPHET model tracks the distribution of the force by years of remaining obligated service, but does not allow reenlistment rates to vary in response to changes in compensation. Conversely, the ACOL model does allow reenlistment rates to vary in response to changes in compensation, but does not track the distribution of the force by years of remaining obligated service. We found that the ACOL projections are more accurate than the PROPHET projections. Evidently, adjusting reenlistment rates in response to pay changes is more important than tracking the force by years of remaining obligated service.

We also ran projections of the two models sequentially, so that the PROPHET model projections of expired obligations were used as an input to the ACOL model. The results of this procedure were superior to those obtained using either model separately. However, we still had a forecast error of 3 to 4 percentage points. To reduce this error, we made allowance for the effect of first-term reenlistment bonuses on subsequent second-term reenlistment rates. This enabled us to reduce the forecast error to about 2 percentage points.

We were able to further reduce the forecast error to almost zero by using information on civilian unemployment during the projection period, FY 78-FY 80. However, this information is only available through hindsight, and would not have been available had the projections actually been made during the base year, FY 77. Therefore, the strongest conclusion possible is that the ACOL projections are accurate to within 2 percentage points, with most of the remaining forecast error being attributable to variation in civilian unemployment over the projection period.

A COMPARISON OF THE PROPHET AND ACOL FORCE PROJECTION MODELS

INTRODUCTION

The Center for Naval Analyses has developed two models for projecting enlisted force levels: the PROPHET model (references 1-3), and the more widely-known ACOL model. (references 4-5). This paper compares the career force projections of these models to actual historical experience over the period FY 78-FY 80. We also refine the ACOL model to allow for the effect of first-term reenlistment bonuses on subsequent second-term reenlistment rates.

DESCRIPTION OF THE MODELS

The PROPHET model uses retention behavior over a base year to estimate reenlistment rates by LOS. These reenlistment rates are then applied to age the enlisted force over all years in the projection period. The reenlistment rates are assumed fixed, and are not allowed to vary in response to changes in compensation over the projection period. The PROPHET model also tracks the distribution of the force by years of remaining obligated service. The reenlistment rates are applied only to those individuals whose obligations expire within each respective year of the projection period.

The ACOL model allows reenlistment rates to vary in response to changes in compensation. This is accomplished by means of a logistic supply function that expresses reenlistment rates by LOS in terms of relative military compensation. The ACOL models does not track the distribution of the force by years of remaining obligated service. Instead, the user must supply his own estimate of the fraction of individuals whose obligations will expire within each year of the projection period.

Both PROPHET and ACOL provide end strength projections only for LOS cells 2-30. The end strength at LOS 1 is determined as a residual, by subtracting the end strength in LOS cells 2-30 from a total end strength goal.

RETENTION BEHAVIOR, FY 78-FY 80

Table 1 presents the end strength by LOS for FY 78-FY 80. We also present total end strength and career force, which is derived by subtracting the end strength in LOS cells 1-4 from total end strength.

Table 2 presents reenlistment rates by LOS for FY 78-FY 80. Table 3 presents the fraction of individuals whose obligations expired, by LOS, for FY 78-FY 80.

TABLE 1
HISTORICAL ENDSTRENGTH

<u>LOS</u>	<u>FY 78</u>	<u>FY 79</u>	<u>FY 80</u>
1	73,728	72,159	78,322
2	78,029	65,719	65,902
3	66,102	70,379	60,622
4	53,783	55,447	60,515
5	24,416	28,593	28,115
6	20,362	20,027	22,496
7	17,447	16,051	15,670
8	15,330	15,520	14,593
9	11,721	12,713	13,193
10	10,814	10,225	11,329
11	9,086	9,538	9,128
12	6,954	8,579	8,991
13	6,854	6,632	8,113
14	8,222	6,622	6,371
15	7,214	7,913	6,388
16	6,978	6,982	7,711
17	8,228	6,752	6,796
18	8,989	8,073	6,628
19	9,360	8,777	7,927
20	6,359	7,768	7,240
21	3,867	3,558	4,002
22	2,208	2,423	2,386
23	1,796	1,504	1,656
24	1,482	1,265	1,089
25	832	1,148	941
26	472	673	915
27	510	343	492
28	351	402	260
29	148	307	340
30+	331	235	322
Total force	461,973	456,327	458,453
Career force	190,331	192,623	193,092

TABLE 2
HISTORICAL REENLISTMENT RATES

<u>LOS</u>	<u>FY 78</u>	<u>FY 79</u>	<u>FY 80</u>
1	.4681	.4779	.3816
2	.4013	.4432	.3790
3	.1898	.1960	.2553
4	.2367	.2244	.2426
5	.3720	.3289	.2961
6	.2830	.3077	.3390
7	.4519	.4585	.5051
8	.4799	.4599	.5094
9	.5678	.5234	.5704
10	.6730	.6255	.6592
11	.7477	.7214	.7411
12	.7716	.7852	.8002
13	.8432	.8467	.8460
14	.8913	.8825	.8863
15	.9302	.9198	.9333
16	.9386	.9345	.9459
17	.9619	.9593	.9497
18	.9304	.9455	.9598
19	.9306	.9504	.9534
20	.3306	.3314	.3041
21	.4438	.3832	.4275
22	.4446	.3795	.4709
23	.5085	.4738	.5528
24	.6481	.5527	.5526
25	.7200	.6196	.6619
26	.5276	.5474	.5508
27	.5500	.5446	.5111
28	.7895	.6452	.6582
29	.5600	.3846	.2954

TABLE 3

HISTORICAL FRACTIONS OF EXPIRED OBLIGATIONS

<u>LOS</u>	<u>FY 78</u>	<u>FY 79</u>	<u>FY 80</u>
1	.0011	.0015	.0018
2	.0081	.0059	.0056
3	.1082	.1324	.126
4	.6200	.6180	.69
5	.1461	.2432	.16
6	.3029	.2985	.25
7	.1388	.1784	.18
8	.3191	.3056	.3
9	.2814	.2569	.25
10	.2960	.2877	.3056
11	.1648	.1580	.1794
12	.1942	.1861	.2322
13	.1300	.1551	.1831
14	.1490	.1677	.2125
15	.1479	.1781	.2124
16	.1720	.1970	.2279
17	.1377	.1343	.1916
18	.1052	.1124	.1569
19	.1666	.1769	.2255
20	.3060	.3288	.3919
21	.2803	.3145	.3373
22	.2331	.2518	.3198
23	.2330	.2339	.2766
24	.2042	.2368	.2403
25	.2140	.2212	.2447
26	.2315	.2013	.2778
27	.2620	.2196	.2623
28	.2317	.1766	.1965
29	.2119	.1757	.2866

Our PROPHET and ACOL projections both employ FY 77 as the base year. The FY 77 end strengths were used as the begin strengths for the first projection year in both cases. In addition, FY 77 data were used to estimate the reenlistment rates employed by PROPHET. We used the actual total endstrength in each of FY 78-FY 80 as the total end strength goal for both models.

The ACOL model requires as inputs the average first- and second-term bonus multiples by year, and the annual percentage increase in relative military pay. We computed the average bonus multiple as a weighted average of the bonus multiples in each rating, where the number of eligibles in the rating serves as the weight. We computed the percentage increase in relative military pay as the difference between the percentage increase in RMC and the percentage increase in wages in the civilian manufacturing sector (reference 6). These inputs are shown in table 4.

PROJECTIONS OF THE PROPHET MODEL

Table 5 contains the PROPHET projections of the fraction of individuals whose obligations expire. These predictions are quite close to the actual values displayed in table 3 above. The ability of PROPHET to track this distribution is the major advantage of the model.

TABLE 4
INPUT INTO ACOL MODEL

	<u>FY 78</u>	<u>FY 79</u>	<u>FY 80</u>
First-term bonus	1.74	1.22	1.57
Second-term bonus	1.08	0.90	2.06
Percent change RMC	6.2	5.5	7.0
Percent change manufacturing wages	8.7	8.2	7.9

TABLE 5

PROPHET PROJECTIONS OF EXPIRED OBLIGATIONS

<u>LOS</u>	<u>FY 78</u>	<u>FY 79</u>	<u>FY 80</u>
1	.0011	.0009	.0008
2	.0044	.0045	.0041
3	.1221	.1195	.1394
4	.6083	.6555	.6970
5	.2219	.2600	.2242
6	.3156	.3015	.3018
7	.1708	.1627	.1401
8	.3158	.3078	.3274
9	.2497	.2389	.2569
10	.2723	.2673	.2868
11	.1394	.1436	.1370
12	.1771	.1979	.1934
13	.1357	.1476	.1503
14	.1518	.1711	.1803
15	.1675	.1785	.1898
16	.1819	.1971	.2143
17	.1352	.1623	.1549
18	.1144	.1422	.1395
19	.1879	.2241	.2069
20	.3480	.3896	.3737
21	.3326	.3705	.3581
22	.2583	.3064	.2963
23	.2543	.2810	.2610
24	.2299	.2323	.2307
25	.2379	.2482	.2386
26	.2514	.2412	.2588
27	.2661	.3038	.3000
28	.2017	.1842	.1939
29	.2041	.2373	.2572

Table 6 contains the PROPHET projections of the endstrength profile. Comparing table 6 to table 1, we see that PROPHET overpredicted the career force in each of the projection years. Recall from table 4 that relative military pay declined over the period FY 78-FY 80. However, PROPHET does not allow reenlistment rates to respond to pay changes. Therefore, the PROPHET projections were overly optimistic during a period of declining relative military pay.

PROJECTIONS OF THE ACOL MODEL

As noted earlier, the ACOL model requires as input an estimate of the fraction of individuals whose obligations expire. One possibility would be to use the actual fractions observed during FY 78 - FY 80. However, this would give the model an unfair advantage, since these fractions are available now through hindsight but would not have been available had the projections actually been made during FY 77.

Another alternative, which provides a fair test of the model, is to apply the fractions observed during the base year, FY 77, throughout the projection period.

A final alternative, which should yield superior results, is to use the projected fractions from the PROPHET model as an input to the ACOL model. That is, we run the two models sequentially.

TABLE 6

PROPHET PROJECTIONS OF ENDSTRENGTH

<u>LOS</u>	<u>FY 78</u>	<u>FY 79</u>	<u>FY 80</u>
1	64,878	78,645	87,982
2	76,830	53,917	65,303
3	66,397	65,701	46,167
4	54,725	54,341	53,768
5	27,106	31,044	29,309
6	20,521	22,824	25,515
7	18,271	16,046	18,022
8	15,727	16,482	14,537
9	12,689	13,819	14,517
10	11,331	11,540	12,603
11	9,347	10,371	10,568
12	7,075	8,978	9,944
13	7,009	6,774	8,572
14	8,278	6,775	6,539
15	7,296	8,045	6,574
16	7,064	7,114	7,839
17	8,286	6,906	6,952
18	9,020	8,109	6,751
19	9,552	8,724	7,828
20	7,382	7,284	6,550
21	4,267	3,779	3,627
22	2,443	2,706	2,356
23	2,045	1,694	1,843
24	1,614	1,438	1,179
25	891	1,229	1,094
26	533	742	1,024
27	590	418	584
28	357	418	294
29	147	295	346
30	302	169	267
Total force	461,973	456,327	458,453
Career force	199,037	203,673	205,202

This procedure does not utilize any information that would have been unavailable had the projections actually been made during FY 77. Moreover, it combines the PROPHET model's ability to track expired obligations with the ACOL model's ability to adjust reenlistment rates to pay changes.

COMPARISONS OF PROPHET AND ACOL PROJECTIONS

Table 7 contains the ACOL model's projections of reenlistment rates. Table 8 contains the ACOL force level projections using FY 77 expired obligations. Table 9 contains the ACOL force level projections using the PROPHET projections of expired obligations. Table 10 summarizes the various projections obtained using PROPHET, ACOL, and the two models sequentially.

It is apparent from table 10 that the PROPHET model is a less effective forecasting tool. This is because PROPHET does not adjust reenlistment rates in response to pay changes. The ACOL model outperforms the PROPHET model, even when the base year fraction of expired obligations is used throughout the projection period. Evidently, adjusting reenlistment rates to pay changes is more important than tracking the distribution of expired obligations. However, the best results are obtained when PROPHET and ACOL are used sequentially. The percentage deviations between these predictions and the actual career force levels are 2.7 percent in FY 78, 2.3 percent in FY 79, and 4.0 percent in FY 80.

TABLE 7

ACOL PROJECTIONS OF REENLISTMENT RATES

<u>LOS</u>	<u>FY 78</u>	<u>FY 79</u>	<u>FY 80</u>
1	.4049	.3934	.3896
2	.1772	.1693	.1667
3	.2024	.1815	.1849
4	.2359	.2124	.2162
5	.4087	.3763	.3786
6	.3106	.2812	.2833
7	.5197	.4931	.5206
8	.5755	.5482	.5768
9	.6152	.5875	.6180
10	.7006	.6735	.6969
11	.7592	.7396	.7328
12	.8434	.8283	.8230
13	.8422	.8260	.8203
14	.8971	.8848	.8805
15	.9297	.9202	.9167
16	.9384	.9288	.9253
17	.9541	.9454	.9421
18	.9526	.9405	.9359
19	.9865	.9798	.9770
20	.3650	.3427	.3355
21	.4115	.3878	.3800
22	.4362	.4087	.3997
23	.5125	.4873	.4789
24	.5767	.5503	.5414
25	.7191	.6950	.6868
26	.7102	.6779	.6667
27	.5305	.5117	.5054
28	.6366	.6187	.6127
29	.3886	.3695	.3633

TABLE 8

ACOL PROJECTIONS OF ENDSTRENGTH,
USING FY 77 EXPIRED OBLIGATIONS

<u>LOS</u>	<u>FY 78</u>	<u>FY 79</u>	<u>FY 80</u>
1	79,320	77,178	81,711
2	76,355	68,990	67,244
3	60,336	62,545	56,632
4	49,761	47,901	49,985
5	24,863	26,213	26,018
6	21,135	22,922	24,249
7	17,974	16,584	18,063
8	15,722	16,677	15,533
9	12,852	14,048	15,073
10	11,649	11,944	13,261
11	9,192	10,442	10,789
12	6,962	8,698	9,870
13	6,944	6,637	8,283
14	8,202	6,654	6,355
15	7,220	7,913	6,416
16	6,981	7,026	7,696
17	8,230	6,810	6,850
18	8,971	8,056	6,664
19	9,587	8,766	7,840
20	9,247	9,475	8,660
21	2,502	3,379	3,444
22	2,171	1,646	2,218
23	1,767	1,467	1,110
24	1,512	1,317	1,092
25	825	1,174	1,021
26	492	692	983
27	547	380	533
28	343	408	283
29	135	282	336
30	177	101	211
Total force	461,973	456,327	458,453
Career force	196,201	199,713	202,881

TABLE 9

ACOL PROJECTIONS OF ENDSTRENGTH,
USING PROPHET PROJECTED EXPIRED OBLIGATIONS

<u>LOS</u>	<u>FY 78</u>	<u>FY 79</u>	<u>FY 80</u>
1	71,259	72,531	81,710
2	76,326	62,007	63,215
3	65,404	67,832	55,300
4	53,543	56,006	57,402
5	26,774	28,345	28,427
6	19,651	22,206	24,197
7	17,651	15,346	17,394
8	15,417	16,114	14,338
9	12,467	13,392	14,067
10	11,714	11,730	12,712
11	9,254	10,597	10,618
12	6,995	8,793	10,076
13	6,966	6,670	8,381
14	8,209	6,670	6,377
15	7,209	7,891	6,401
16	6,965	6,991	7,642
17	8,210	6,769	6,782
18	8,960	8,016	6,607
19	9,577	8,733	7,809
20	9,246	9,458	8,621
21	2,497	3,346	3,402
22	2,057	1,517	2,038
23	1,708	1,307	965
24	1,456	1,208	929
25	802	1,093	905
26	484	658	897
27	541	368	497
28	326	376	256
29	132	263	303
30	172	94	184
Total force	461,973	456,327	458,453
Career force	195,441	197,951	200,826

TABLE 10
SUMMARY OF CAREER FORCE PROJECTIONS

	<u>FY 78</u>	<u>% error</u>	<u>FY 79</u>	<u>% error</u>	<u>FY 80</u>	<u>% error</u>
Historical	190,331	-	192,623	-	193,092	-
PROPHET	199,037	+4.6	203,673	+5.7	205,202	+6.3
ACOL, using FY 77 expired obligations	196,201	+3.0	199,713	+3.7	202,881	+5.1
ACOL, using PROPHET projected expired obligations	195,441	+2.7	197,951	+2.8	200,826	+4.0

REFINING THE ACOL PROJECTIONS

Although ACOL, as currently calibrated, overestimates the career force level, it appears to underestimate the responsiveness of the force level to pay changes. Relative military pay declined over the period FY 78-FY 80. The ACOL model did adjust reenlistment rates downward in response to this trend, but apparently did not do so to a sufficient extent. This seems to suggest recalibrating the pay coefficient in the logistic supply function to obtain greater conformity between the ACOL model's projections and historical data. However, there is independent evidence that the pay coefficient is correctly estimated.¹ Therefore, we have chosen not to pursue this option.

Instead, we have sought variables other than pay whose behavior over the period FY 78-FY 80 could improve the accuracy of the ACOL projections. One such variable is the civilian

¹Reference 4 provides the logit estimate of .000227 that we employ in our analysis. This estimate was obtained using FY 77 data. Alternatively, reference 7 provides probit estimates of pay coefficients for 28 rating groups, using FY 74 data. We calculated a weighted average of these probit estimates, using the number of reenlistment eligibles in the rating as the weight. This weighted average equals .000171. However, comparability requires that this probit estimate be re-scaled to reflect the 27 percent cumulative inflation that occurred between FY 74 and FY 77. Moreover, the probit estimate must be converted to a logit estimate, using the approximate conversion factor of $\pi/\sqrt{3}$ (reference 8, pages 5-6). Performing the two corrections, we arrive at an estimate of .000244, which is nearly identical to the logit estimate of .000227 employed in our analysis.

unemployment rate. Increased civilian unemployment represents a deterioration in alternatives to military service, hence we expect that an increase in the civilian unemployment rate will lead to an increase in the reenlistment rate.

We also investigated the effect of first-term reenlistment bonuses on subsequent second-term reenlistment rates. Warner argues (references 5,7) that first-term bonuses induce reenlistments on the part of individuals with lower tastes for military service than those who would have reenlisted in the absence of the bonuses. These marginal individuals are less likely to reenlist when they reach their second-term decision point.

To determine the magnitudes of these effects, we pooled data on second-termers in 90 ratings over the period FY 77-FY 80. We expressed the second-term reenlistment rate as a function of the contemporaneous second-term bonus multiple, the contemporaneous civilian unemployment rate among males aged 25-34, and the first-term bonus multiple that prevailed five years earlier. The lag of five years in the first-term bonus multiple was chosen to represent the average length of a first-term reenlistment. That is, first-term individuals who are induced to reenlist by bonuses will face their second reenlistment decision on average five years later, hence it will take about five years until first-term bonuses have their effect upon the second-term reenlistment rate.

We estimated that an increase of one percentage point in the civilian unemployment rate will lead to 2.7 additional reenlistments per 100 eligibles. We also estimated that a unit increase in the first-term bonus multiple will lead to 2.1 fewer second-term reenlistments per 100 eligibles five years later.¹

REVISED ACOL PROJECTIONS

We revised the ACOL projections to incorporate the effects of civilian unemployment and lagged first-term bonuses. To accomplish this, we expanded the logistic supply function to include these two variables in addition to the relative military compensation variable. We employed the regression coefficients reported in the previous section. We also adjusted the intercept so that the inclusion of the two additional variables would leave the projections unchanged when evaluated at the base year values of all variables. Moreover, PROPHET projections of expired obligations were employed throughout.

¹Our estimated regression equation was:

$$\log (R/(1-R)) = -.262 - .0726 X_1 + .109 X_2 - .0857 X_3,$$

(-3.93) (3.78) (-1.15)

where R is the reenlistment rate, X_1 is the second-term bonus multiple, X_2 is the civilian unemployment rate, and X_3 is the first-term bonus multiple lagged five years. This equation was estimated by generalized least squares, and t-statistics are reported in parentheses. The partial effects reported in the text are obtained after multiplying the regression coefficients by the factor $R(1-R)$.

The values of the civilian unemployment rate and the lagged first-term bonus are displayed in table 11. The first-term bonus was computed as a weighted average of the bonus multiples in each rating, where the number of eligibles serves as the weight. No methodological issue arises from the inclusion of the lagged first-term bonus, since these values would have been available had the projections actually been made during FY 77. However, apart from the base year, the actual civilian unemployment rates would not have been available in FY 77. These values are only available through hindsight. Therefore, tables 12-13 report the ACOL projections that employ only the lagged first-term bonus, while tables 14-15 report those that employ both the lagged first-term bonus and the civilian unemployment rate.

Table 16 is a summary table. The first two rows of table 16 repeat the historical career force levels and the ACOL projections which ignore both lagged first-term bonuses and civilian unemployment. The third row presents the ACOL projections which include the lagged first-term bonuses. These projections are quite close to the historical values, lying within 2 percentage points in all three projection years.

The last row of table 16 presents the ACOL projections which include the civilian unemployment rate as well as the lagged first-term bonus. These projections are slightly higher than the historical value in FY 78 and slightly lower in FY 79-FY 80, but

TABLE 11
DATA FOR REVISED ACOL PROJECTIONS

	<u>First-term bonus</u>		<u>Civilian unemployment rate</u>
FY 72	3.17	FY 77	5.9
FY 73	3.26	FY 78	4.5
FY 74	2.71	FY 79	3.8
FY 75	2.56	FY 80	6.1

TABLE 12

ACOL REENLISTMENT RATES USING LAGGED BONUSES

<u>LOS</u>	<u>FY 78</u>	<u>FY 79</u>	<u>FY 80</u>
1	.4049	.3934	.3896
2	.1772	.1693	.1667
3	.2024	.1815	.1849
4	.2359	.2124	.2162
5	.4087	.3763	.3786
6	.3106	.2812	.2833
7	.5197	.4931	.5206
8	.5755	.5482	.5768
9	.6152	.5875	.6180
10	.7006	.6735	.6969
11	.7592	.7396	.7328
12	.8434	.8283	.8230
13	.8422	.8260	.8203
14	.8971	.8848	.8805
15	.9297	.9202	.9167
16	.9384	.9288	.9253
17	.9541	.9454	.9421
18	.9526	.9405	.9359
19	.9865	.9798	.9770
20	.3650	.3427	.3355
21	.4115	.3878	.3800
22	.4362	.4087	.3997
23	.5125	.4873	.4789
24	.5767	.5503	.5414
25	.7191	.6950	.6868
26	.7102	.6779	.6667
27	.5305	.5117	.5054
28	.6366	.6187	.6127
29	.3886	.3695	.3633

TABLE 13

ACOL FORCE LEVELS USING LAGGED BONUSES

<u>LOS</u>	<u>FY 78</u>	<u>FY 79</u>	<u>FY 80</u>
1	73,036	74,233	83,456
2	76,326	63,542	64,685
3	65,404	67,832	56,657
4	53,543	56,006	57,402
5	26,774	28,345	28,427
6	19,651	22,206	24,197
7	17,651	15,346	17,394
8	15,027	15,761	14,077
9	11,851	12,481	13,137
10	11,293	10,828	11,515
11	8,904	9,858	9,453
12	6,995	8,461	9,374
13	6,966	6,670	8,064
14	8,209	6,670	6,377
15	7,209	7,891	6,401
16	6,965	6,991	7,642
17	8,210	6,769	6,782
18	8,960	8,016	6,607
19	9,577	8,733	7,809
20	9,246	9,458	8,621
21	2,497	3,346	3,402
22	2,057	1,517	2,038
23	1,708	1,307	965
24	1,456	1,208	929
25	802	1,093	905
26	484	658	897
27	541	368	497
28	326	376	256
29	132	263	303
30	172	94	184
Total force	461,973	456,327	458,453
Career force	193,663	194,714	196,254

TABLE 14

ACOL REENLISTMENT RATES USING LAGGED
BONUSES AND CIVILIAN UNEMPLOYMENT

<u>LOS</u>	<u>FY 78</u>	<u>FY 79</u>	<u>FY 80</u>
1	.3687	.3403	.3948
2	.1560	.1395	.1698
3	.1789	.1499	.1822
4	.2095	.1767	.2199
5	.3724	.3242	.3837
6	.2789	.2374	.2878
7	.3487	.3185	.4045
8	.4014	.3684	.4602
9	.4417	.4063	.5030
10	.5366	.4978	.5899
11	.7302	.6931	.7370
12	.8222	.7933	.8262
13	.8208	.7906	.8235
14	.8821	.8594	.8827
15	.9191	.9017	.9184
16	.9290	.9121	.9268
17	.9470	.9323	.9433
18	.9452	.9264	.9372
19	.9843	.9748	.9775
20	.3304	.2932	.3403
21	.3751	.3350	.3851
22	.3991	.3548	.4049
23	.4744	.4305	.4843
24	.5391	.4932	.5468
25	.6873	.6445	.6914
26	.6778	.6260	.6715
27	.4924	.4546	.5108
28	.6007	.5635	.6179
29	.3530	.3180	.3683

TABLE 15

ACOL FORCE LEVELS USING LAGGED
BONUSES AND CIVILIAN UNEMPLOYMENT

<u>LOS</u>	<u>FY 78</u>	<u>FY 79</u>	<u>FY 80</u>
1	75,198	77,542	82,781
2	76,323	65,406	67,544
3	65,397	67,818	58,304
4	53,364	55,753	57,422
5	26,043	27,007	28,457
6	19,467	21,259	23,110
7	17,424	14,949	16,703
8	14,925	15,415	13,732
9	11,684	12,147	12,884
10	11,176	10,528	11,246
11	8,800	9,585	9,207
12	6,966	8,303	9,120
13	6,939	6,593	7,919
14	8,184	6,607	6,307
15	7,192	7,832	6,344
16	6,952	6,951	7,587
17	8,196	6,733	6,745
18	8,951	7,985	6,574
19	9,569	8,707	7,780
20	9,242	9,439	8,595
21	2,416	3,166	3,412
22	2,017	1,421	1,934
23	1,683	1,249	906
24	1,436	1,163	890
25	793	1,060	873
26	479	640	870
27	535	359	485
28	321	363	250
29	131	256	292
30	170	92	179
Total force	461,973	456,327	458,453
Career force	191,692	189,807	192,402

TABLE 16
SUMMARY OF REVISED ACOL PROJECTIONS

	<u>FY 78</u>	<u>% error</u>	<u>FY 79</u>	<u>% error</u>	<u>FY 80</u>	<u>% error</u>
Historical	190,331	-	192,623	-	193,092	-
ACOL	195,441	+2.7	197,951	+2.8	200,826	+4.0
ACOL with lagged bonuses	193,663	+1.8	194,714	+1.1	196,254	+1.6
ACOL, with lagged bonuses and civilian unemployment	191,692	+0.7	189,807	-1.5	192,402	-0.4

are always within 1.5 percentage points. They are the most accurate forecasts that we have been able to obtain. However, they do rely upon information which is only available through hindsight. Therefore, the strongest conclusion that we can reach is that the ACOL projections for careerists, corrected for lagged first-term bonuses, are accurate to within 2 percentage points. Most of the remaining forecast error can be attributed to variation in civilian unemployment over the projection period.

CONCLUSIONS

We compared the projections of the PROPHET and ACOL models to historical experience over the period FY 78 - FY 80. The PROPHET model tracks the distribution of the force by years of remaining obligated service, but does not allow reenlistment rates to vary in response to changes in compensation. Conversely, the ACOL model does allow reenlistment rates to vary in response to changes in compensation, but does not track the distribution of the force by years of remaining obligated service. We found that the ACOL projections are more accurate than the PROPHET projections. Evidently, adjusting reenlistment rates in response to pay changes is more important than tracking the force by years of remaining obligated service.

We also ran projections of the two models sequentially, so that the PROPHET model projections of expired obligations were

used as an input to the ACOL model. The results of this procedure were superior to those obtained using either model separately. However, we still had a forecast error of 3 to 4 percentage points. To reduce this error, we made allowance for the effect of first-term reenlistment bonuses on subsequent second-term reenlistment rates. This enabled us to reduce the forecast error to about 2 percentage points.

We were able to further reduce the forecast error to almost zero by using information on civilian unemployment during the projection period, FY 78-FY 80. However, this information is only available through hindsight, and would not have been available had the projections actually been made during the base year, FY 77. Therefore, the strongest conclusion possible is that the ACOL projections are accurate to within 2 percentage points, with most of the remaining forecast error being attributable to variation in civilian unemployment over the projection period.

REFERENCES

1. Center for Naval Analyses, Memorandum (CNA)77-1310, "Projections of Navy Enlisted Endstrength with the PROPHET Model: FY 1977-83," by Peter B. McWhite, Unclassified, 30 Aug 1977
2. Center for Naval Analyses, Memorandum (CNA)78-0045, "Models for Enlisted Manpower and Personnel Planning," by Robert F. Lockman, Cdr. Edward M. Barrow, and Robert H. Simmons, Unclassified, 3 Apr 1978
3. Center for Naval Analyses, Research Contribution 346, "The PROPHET System for Projection of Inventories in Ratings and Other Subpopulations," by Marc D. Joseph, Unclassified, May 1978
4. Center for Naval Analyses, Research Contribution 376, "Alternative Military Retirement Systems: Their Effects On Enlisted Retention," by John T. Warner, Unclassified, Sep 1979
5. Center for Naval Analyses, Research Contribution 436, "Military Compensation and Retention: An Analysis of Alternative Models and a Simulation of a New Retention Model," by John T. Warner, forthcoming
6. "Employment and Earnings," U.S. Department of Labor, Bureau of Labor Statistics
7. Center for Naval Analyses, Memorandum (CNA)79-1878, "An Empirical Analysis of Pay and Navy Enlisted Retention in the AVF: Preliminary Results," by John T. Warner and Bruce Simon, 21 Dec 1979
8. Norman L. Johnson and Samuel Katz, "Distributions in Statistics: Continuous Univariate Distributions - Vol. 2," Boston, 1970

CNA PROFESSIONAL PAPERS - 1978 TO PRESENT*

- PP 211
Mizrahi, Maurice M., "On Approximating the Circular Coverage Function," 14 pp., Feb 1978, AD A054 429
- PP 212
Mangel, Marc, "On Singular Characteristic Initial Value Problems with Unique Solution," 20 pp., Jun 1978, AD A058 535
- PP 213
Mangel, Marc, "Fluctuations in Systems with Multiple Steady States. Application to Lanchester Equations," 12 pp., Feb 78 (Presented at the First Annual Workshop on the Information Linkage Between Applied Mathematics and Industry, Naval PG School, Feb 23-25, 1978), AD A071 472
- PP 214
Weinland, Robert G., "A Somewhat Different View of The Optimal Naval Posture," 37 pp., Jun 1978 (Presented at the 1976 Convention of the American Political Science Association (APSA/IUS Panel on "Changing Strategic Requirements and Military Posture"), Chicago, Ill., September 2, 1976), AD A056 228
- PP 215
Colle, Russell C., "Comments on: Principles of Information Retrieval by Manfred Kochen," 10 pp., Mar 78 (Published as a Letter to the Editor, Journal of Documentation, Vol. 31, No. 4, pages 298-301), December 1975), AD A054 426
- PP 216
Colle, Russell C., "Lotka's Frequency Distribution of Scientific Productivity," 18 pp., Feb 1978 (Published in the Journal of the American Society for Information Science, Vol. 28, No. 6, pp. 366-370, November 1977), AD A054 425
- PP 217
Colle, Russell C., "Bibliometric Studies of Scientific Productivity," 17 pp., Mar 78 (Presented at the Annual meeting of the American Society for Information Science held in San Francisco, California, October 1976), AD A054 442
- PP 218 - Classified
- PP 219
Huntzinger, R. LeVar, "Market Analysis with Rational Expectations: Theory and Estimation," 60 pp., Apr 78, AD A054 422
- PP 220
Maurer, Donald E., "Diagonalization by Group Matrices," 26 pp., Apr 78, AD A054 443
- PP 221
Weinland, Robert G., "Superpower Naval Diplomacy in the October 1973 Arab-Israeli War," 76 pp., Jun 1978 (Published in Seapower in the Mediterranean: Political Utility and Military Constraints, The Washington Papers No. 61, Beverly Hills and London: Sage Publications, 1979) AD A055 564
- PP 222
Mizrahi, Maurice M., "Correspondence Rules and Path Integrals," 30 pp., Jun 1978 (Invited paper presented at the CNRS meeting on "Mathematical Problems in Feynman's Path Integrals," Marseille, France, May 22-26, 1978) (Published in Springer Verlag Lecture Notes in Physics, 106, (1979), 234-253) AD A055 536
- PP 223
Mangel, Marc, "Stochastic Mechanics of Molecule on Molecule Reactions," 21 pp., Jun 1978, AD A056 227
- PP 224
Manger, Marc, "Aggregation, Bifurcation, and Extinction in Exploited Animal Populations," 48 pp., Mar 1978, AD A058 536
*Portions of this work were started at the Institute of Applied Mathematics and Statistics, University of British Columbia, Vancouver, B.C., Canada
- PP 225
Mangel, Marc, "Oscillations, Fluctuations, and the Hopf Bifurcation," 43 pp., Jun 1978, AD A058 537
*Portions of this work were completed at the Institute of Applied Mathematics and Statistics, University of British Columbia, Vancouver, Canada.
- PP 226
Raiston, J. M. and J. W. Mann,* "Temperature and Current Dependence of Degradation in Red-Emitting GaP LEDs," 34 pp., Jun 1978 (Published in Journal of Applied Physics, 50, 3630, May 1979) AD A058 538
*Bell Telephone Laboratories, Inc.
- PP 227
Mangel, Marc, "Uniform Treatment of Fluctuations at Critical Points," 50 pp., May 1978, AD A058 539
- PP 228
Mangel, Marc, "Relaxation at Critical Points: Deterministic and Stochastic Theory," 54 pp., Jun 1978, AD A058 540
- PP 229
Mangel, Marc, "Diffusion Theory of Reaction Rates, I: Formulation and Einstein-Smoluchowski Approximation," 50 pp., Jan 1978, AD A058 541
- PP 230
Mangel, Marc, "Diffusion Theory of Reaction Rates, II Ornstein-Uhlenbeck Approximation," 34 pp., Feb 1978, AD A058 542
- PP 231
Wilson, Desmond P., Jr., "Naval Projection Forces: The Case for a Responsive MAF," Aug 1978, AD A054 543
- PP 232
Jacobson, Louis, "Can Policy Changes Be Made Acceptable to Labor?" Aug 1978 (Submitted for publication in Industrial and Labor Relations Review), AD A061 528

*CNA Professional Papers with an AD number may be obtained from the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22151. Other papers are available from the Management Information Office, Center for Naval Analyses, 2000 North Beauregard Street, Alexandria, Virginia 22311. An Index of Selected Publications is also available on request. The Index includes a Listing of Professional Papers; with abstracts; issued from 1969 to June 1981.

- PP 233
Jacobson, Louis, "An Alternative Explanation of the Cyclical Pattern of Quits," 23 pp., Sep 1978
- PP 234 - Revised
Jondrow, James and Levy, Robert A., "Does Federal Expenditure Displace State and Local Expenditure: The Case of Construction Grants," 25 pp., Oct 1979, AD A061 529
- PP 235
Mizreh, Maurice M., "The Semiclassical Expansion of the Anharmonic-Oscillator Propagator," 41 pp., Oct 1978 (Published in Journal of Mathematical Physics 20 (1979) pp. 844-855), AD A061 538
- PP 237
Maurer, Donald, "A Matrix Criterion for Normal Integral Bases," 10 pp., Jan 1979 (Published in the Illinois Journal of Mathematics, Vol. 22 (1978), pp. 672-681)
- PP 238
Utgoff, Kathleen Classen, "Unemployment Insurance and The Employment Rate," 20 pp., Oct 1978 (Presented at the Conference on Economic Indicators and Performance: The Current Dilemmas Facing Government and Business Leaders, presented by Indiana University Graduate School of Business). AD A061 527
- PP 239
Trost, R. P. and Warner, J. T., "The Effects of Military Occupational Training on Civilian Earnings: An Income Selectivity Approach," 38 pp., Nov 1979k, AD A077 831
- PP 240
Powers, Bruce, "Goals of the Center for Naval Analyses," 13 pp., Dec 1978, AD A063 759
- PP 241
Mangel, Marc, "Fluctuations at Chemical Instabilities," 24 pp., Dec 1978 (Published in Journal of Chemical Physics, Vol. 69, No. 8, Oct 15, 1978). AD A063 787
- PP 242
Simpson, William R., "The Analysis of Dynamically Interactive Systems (Air Combat by the Numbers)," 160 pp., Dec 1978, AD A063 760
- PP 243
Simpson, William R., "A Probabilistic Formulation of Murphy Dynamics as Applied to the Analysis of Operational Research Problems," 18 pp., Dec 1978, AD A063 761
- PP 244
Sherman, Allen and Horowitz, Stanley A., "Maintenance Costs of Complex Equipment," 20 pp., Dec 1978 (Published By The American Society of Naval Engineers, Naval Engineers Journal, Vol. 91, No. 6, Dec 1979) AD A071 473
- PP 245
Simpson, William R., "The Accelerometer Methods of Obtaining Aircraft Performance from Flight Test Data (Dynamic Performance Testing)," 403 pp., Jun 1979, AD A075 226
- PP 246
Brechtling, Frank, "Layoffs and Unemployment Insurance," 35 pp., Feb 1979 (Presented at the Nber Conference on "Low Income Labor Markets," Chicago, Jun 1978), AD A096 629
- PP 248
Thomas, James A., Jr., "The Transport Properties of Dilute Gases in Applied Fields," 183 pp., Mar 1979, AD A096 464
- PP 249
Glasser, Kenneth S., "A Secretary Problem with a Random Number of Choices," 23 pp., Mar 1979
- PP 250
Mangel, Marc, "Modeling Fluctuations in Macroscopic Systems," 26 pp., Jun 1979
- PP 251
Trost, Robert P., "The Estimation and Interpretation of Several Selectivity Models," 37 pp., Jun 1979, AD A075 941
- PP 252
Nunn, Walter R., "Position Finding with Prior Knowledge of Covariance Parameters," 5 pp., Jun 1979 (Published in IEEE Transactions on Aerospace & Electronic Systems, Vol. AES-15, No. 3, Mar 1979)
- PP 253
Glasser, Kenneth S., "The d-Choice Secretary Problem," 32 pp., Jun 1979, AD A075 225
- PP 254
Mangel, Marc and Quanbeck, David B., "Integration of a Bivariate Normal Over an Offset Circle," 14 pp., Jun 1979, AD A096 471
- PP 255 - Classified, AD B051 441L
- PP 256
Maurer, Donald E., "Using Personnel Distribution Models," 27 pp., Feb 1980, AD A082 218
- PP 257
Thaler, R., "Discounting and Fiscal Constraints: Why Discounting is Always Right," 10 pp., Aug 1979, AD A075 224
- PP 258
Mangel, Marc S. and Thomas, James A., Jr., "Analytical Methods in Search Theory," 86 pp., Nov 1979, AD A077 832
- PP 259
Glass, David V.; Hsu, Ih-Ching; Nunn, Walter R., and Perlin, David A., "A Class of Commutative Markov Matrices," 17 pp., Nov 1979, AD A077 833
- PP 260
Mangel, Marc S. and Cope, Davis K., "Detection Rate and Sweep Width in Visual Search," 14 pp., Nov 1979, AD A077 834
- PP 261
Villa, Carlos L.; Zvijac, David J. and Ross, John, "Franck-Condon Theory of Chemical Dynamics. VI. Angular Distributions of Reaction Products," 14 pp., Nov 1979 (Reprinted from Journal Chemical Phys. 70(12), 15 Jun 1979), AD A076 287
- PP 262
Petersen, Charles C., "Third World Military Elites in Soviet Perspective," 50 pp., Nov 1979, AD A077 835
- PP 263
Robinson, Kathy I., "Using Commercial Tankers and Container-ships for Navy Underway Replenishment," 25 pp., Nov 1979, AD A077 836

PP 264

Weinland, Robert G., "The U.S. Navy in the Pacific: Past, Present, and Glimpses of the Future," 31 pp., Nov 1979 (Delivered at the International Symposium on the Sea, sponsored by the International Institute for Strategic Studies, The Brookings Institution and the Yomiuri Shimbun, Tokyo, 16-20 Oct 1978) AD A066 837

PP 265

Weinland, Robert G., "War and Peace in the North: Some Political Implications of the Changing Military Situation in Northern Europe," 18 pp., Nov 1979 (Prepared for presentation to the Conference of the Nordic Balance in Perspective: The Changing Military and Political Situation," Center for Strategic and International Studies, Georgetown University, Jun 15-16, 1978) AD A077 838

PP 266

Utgoff, Kathy Classen, and Brechling, Frank, "Taxes and Inflation," 25 pp., Nov 1979, AD A081 194

PP 267

Trost, Robert P., and Vogel, Robert C., "The Response of State Government Receipts to Economic Fluctuations and the Allocation of Counter-Cyclical Revenue Sharing Grants," 12 pp., Dec 1979 (Reprinted from the Review of Economics and Statistics, Vol. LXI, No. 3, August 1979)

PP 268

Thomson, James S., "Seaport Dependence and Inter-State Cooperation: The Case of Sub-Saharan Africa," 141 pp., Jan 1980, AD A081 193

PP 269

Weiss, Kenneth G., "The Soviet Involvement in the Ogaden War," 42 pp., Jan 1980 (Presented at the Southern Conference on Slavic Studies in October, 1979), AD A082 219

PP 270

Remnek, Richard, "Soviet Policy in the Horn of Africa: The Decision to Intervene," 52 pp., Jan 1980 (To be published in "The Soviet Union in the Third World: Success or Failure," ed. by Robert M. Donaldson, Westview Press, Boulder, Co., Summer 1980), AD A081 195

PP 271

McConnell, James, "Soviet and American Strategic Doctrines: One More Time," 43 pp., Jan 1980, AD A081 192

PP 272

Weiss, Kenneth G., "The Azores in Diplomacy and Strategy, 1940-1945," 46 pp., Mar 1980, AD A085 094

PP 273

Nakada, Michael K., "Labor Supply of Wives with Husbands Employed Either Full Time or Part Time," 39 pp., Mar 1980, AD A082 220

PP 274

Nunn, Walter R., "A Result in the Theory of Spiral Search," 9 pp., Mar 1980

PP 275

Goldberg, Lawrence, "Recruiters Advertising and Navy Enlistments," 34 pp., Mar 1980, AD A082 221

PP 276

Goldberg, Lawrence, "Delaying an Overhaul and Ship's Equipment," 40 pp., May 1980, AD A085 095

PP 277

Mangel, Marc, "Small Fluctuations in Systems with Multiple Limit Cycles," 19 pp., Mar 1980 (Published in SIAM J. Appl. Math., Vol. 38, No. 1, Feb 1980) AD A086 229

PP 278

Mizrahi, Maurice, "A Targeting Problem: Exact vs. Expected-Value Approaches," 23 pp., Apr 1980, AD A085 096

PP 279

Walt, Stephen M., "Causal Inferences and the Use of Force: A Critique of Force Without War," 50 pp., May 1980, AD A085 097

PP 280

Goldberg, Lawrence, "Estimation of the Effects of A Ship's Steaming on the Failure Rate of its Equipment: An Application of Econometric Analysis," 25 pp., Apr 1980, AD A085 098

PP 281

Mizrahi, Maurice M., "Comment on 'Discretization Problems of Functional Integrals in Phase Space'," 2 pp., May 1980, published in "Physical Review D", Vol. 22 (1980), AD A094 994

PP 283

Dismukes, Bradford, "Expected Demand for the U.S. Navy to Serve as An Instrument of U.S. Foreign Policy: Thinking About Political and Military Environmental Factors," 30 pp., Apr 1980, AD A085 099

PP 284

J. Kellison, W. Nunn, and U. Sumita,** "The Laguerre Transform," 119 pp., May 1980, AD A085 100
*The Graduate School of Management, University of Rochester and the Center for Naval Analyses
**The Graduate School of Management, University of Rochester

PP 285

Remnek, Richard B., "Superpower Security Interests in the Indian Ocean Area," 26 pp., Jun 1980, AD A087 113

PP 286

Mizrahi, Maurice M., "On the MKB Approximation to the Propagator for Arbitrary Hamiltonians," 25 pp., Aug 1980 (Published in Journal of Math. Phys., 22(1) Jan 1981), AD A091 307

PP 287

Cope, Davis, "Limit Cycle Solutions of Reaction-Diffusion Equations," 35 pp., Jun 1980, AD A087 114

PP 288

Golman, Walter, "Don't Let Your Slides Flip You: A Painless Guide to Visuals That Really Aid," 28 pp., (revised Aug 1982), AD A092 732

PP 289

Robinson, Jack, "Adequate Classification Guidance - A Solution and a Problem," 7 pp., Aug 1980, AD A091 212

PP 290

Watson, Gregory H., "Evaluation of Computer Software in an Operational Environment," 17 pp., Aug 1980, AD A091 213

PP 291

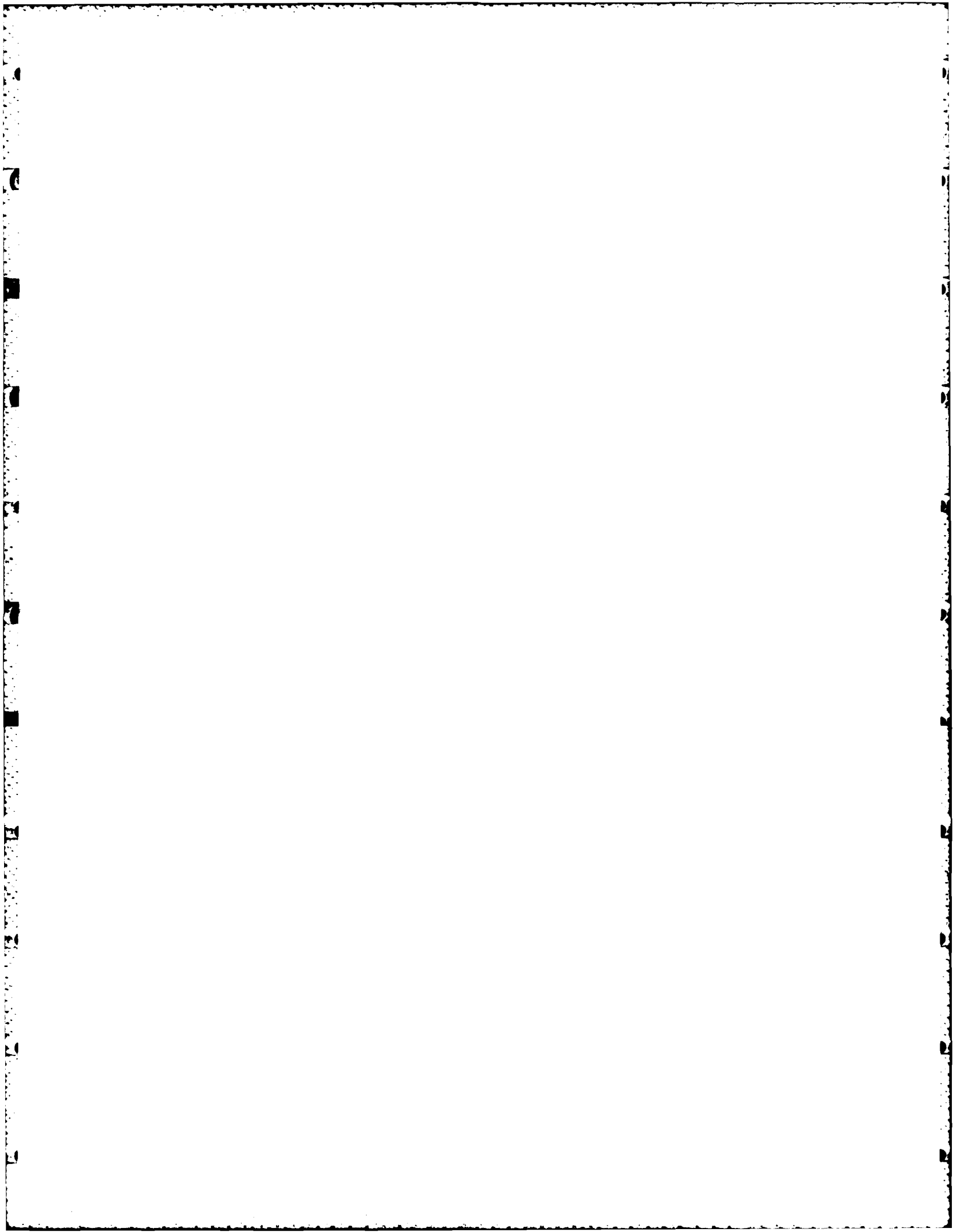
Maddala, G. S., and Trost, R. P., "Some Extensions of the Nerlove Press Model," 17 pp., Oct 1980, AD A091 946
*University of Florida

- PP 292
Thomas, James A., Jr., "The Transport Properties of Binary Gas Mixtures in Applied Magnetic Fields," 10 pp., Sept 1980 (Published in Journal of Chemical Physics 72(10), 15 May 1980)
- PP 293
Thomas, James A., Jr., "Evaluation of Kinetic Theory Collision Integrals Using the Generalized Phase Shift Approach," 12 pp., Sept 1980 (Printed in Journal of Chemical Physics 72(10), 15 May 1980)
- PP 294
Roberts, Stephen S., "French Naval Policy Outside of Europe," 30 pp., Sept 1980 (Presented at the Conference of the Section on Military Studies, International Studies Association Kilauea Island, S.C.), AD A091 306
- PP 295
Roberts, Stephen S., "An Indicator of Informal Empire: Patterns of U.S. Navy Cruising on Overseas Stations, 1869-1897," 40 pp., Sept 1980 (Presented at Fourth Naval History Symposium, US Naval Academy, 26 October 1979, AD A091 316)
- PP 296
Dismukes, Bradford and Petersen, Charles C., "Maritime Factors Affecting Iberian Security," (Factores Maritimos que Afectan la Seguridad Iberica) 14 pp., Oct 1980, AD A092 733
- PP 297 - Classified
- PP 298
Mizrahi, Maurice M., "A Markov Approach to Large Missile Attacks," 31 pp., Jan 1981, AD A096,159
- PP 299
Jondrow, James M. and Levy, Robert A., "Wage Leadership in Construction," 19 pp., Jan 1981, AD A094 797
- PP 300
Jondrow, James and Schmidt, Peter,* "On the Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model," 11 pp., Jan 1981, AD A096 160
*Michigan State University
- PP 301
Jondrow, James M.; Levy, Robert A. and Hughes, Claire, "Technical Change and Employment in Steel, Autos, Aluminum, and Iron Ore," 17 pp., Mar 1981, AD A099 394
- PP 302
Jondrow, James M. and Levy, Robert A., "The Effect of Imports on Employment Under Rational Expectations," 19 pp., Apr 1981, AD A099 392
- PP 303
Thomason, James, "The Rarest Commodity in the Coming Resource Wars," 3 pp., Aug 1981 (Published in the Washington Star, April 13, 1981), AD A104 221
- PP 304
Duffy, Michael K.; Greenwood, Michael J.* and McDowell, John M.,** "A Cross-Sectional Model of Annual Interregional Migration and Employment Growth: Intertemporal Evidence of Structural Change, 1958-1975," 31 pp., Apr 1981, AD A099 393
*University of Colorado
**Arizona State University
- PP 305
Nunn, Laura H., "An Introduction to the Literature of Search Theory," 32 pp., Jun 1981, AD A100 420
- PP 306
Anger, Thomas E., "What Good Are Warfare Models?" 7 pp., May 1981, AD A100 421
- PP 307
Thomason, James, "Dependence, Risk, and Vulnerability," 43 pp., Jun 1981, AD A102 698
- PP 308
Mizrahi, M.M., "Correspondence Rules and Path Integrals," Jul 1981, Published in "Nuovo Cimento B", Vol. 61 (1981), AD A102 699
- PP 309
Weinland, Robert G., "An (The?) Explanation of the Soviet Invasion of Afghanistan," 44 pp., May 1981, AD A100 422
- PP 310
Stanford, Janette M. and Tai Te Wu,* "A Predictive Method for Determining Possible Three-dimensional Foldings of Immunoglobulin Backbones Around Antibody Combining Sites," 19 pp., Jun 1981 (Published in J. theor. Biol. (1981) 88, 421-439, AD A100 423
*Northwestern University, Evanston, IL
- PP 311
Bowes, Marianne, Brechling, Frank P. R., and Utgoff, Kathleen P. Classen, "An Evaluation of UI Funds," 13 pp., May 1981 (Published in National Commission on Unemployment Compensation's Unemployment Compensation: Studies and Research, Volume 2, July 1980), AD A100 424
- PP 312
Jondrow, James; Bowes, Marianne and Levy, Robert, "The Optimum Speed Limit," 23 pp., May 1981, AD A 100 425
- PP 313
Roberts, Stephen S., "The U.S. Navy in the 1980s," 36 pp., Jul 1981, AD A 102 696
- PP 314
Jehn, Christopher; Horowitz, Stanley A. and Lockman, Robert F., "Examining the Draft Debate," 20 pp., Jul 1981, AD A106 192
- PP 315
Buck, Ralph V., Capt., "Le Catastrophe by any other name....," 4 pp., Jul 1981, AD A102 597
- PP 316
Roberts, Stephen S., "Western European and NATO Navies, 1980," 20 pp., Aug 1981, AD A104 223
- PP 317
Roberts, Stephen S., "Superpower Naval Crisis Management in the Mediterranean," 35 pp., Aug 1981, AD A104 222
- PP 318
Vego, Milan N., "Yugoslavia and the Soviet Policy of Force in the Mediterranean Since 1961," 187 pp., Aug 1981

- PP 319
Smith, Michael W., "Anti-air Warfare Defense of Ships at Sea," 46 pp., Sep 1981 (This talk was delivered at the Naval Warfare System and Technology Conference of the American Institute of Aeronautics and Astronautics in Washington on December 12, 1980; in Boston on January 20, 1981; and in Los Angeles on June 12, 1981.), AD A106 191
- PP 320
Trost, R. P.; Lurie, Philip and Berger, Edward, "A Note on Estimating Continuous Time Decision Models," 15 pp., Sep 1981, AD A106 193
- PP 321
Duffy, Michael K. and Ladman, Jerry R.,* "The Simultaneous Determination of Income and Employment in United States--Mexico Border Region Economies," 34 pp., Sep 1981
*Associate Professor of Economics, Arizona State University, Tempe, AZ., AD A106 540
- PP 322
Warner, John T., "Issues in Navy Manpower Research and Policy: An Economist's Perspective," 66 pp., Dec 1981, AD A110 221
- PP 323
Bomse, Frederick M., "Generation of Correlated Log-Normal Sequences for the Simulation of Clutter Echoes," 33 pp., Dec 1981.
- PP 324
Horowitz, Stanley A., "Quantifying Seapower Readiness," 6 pp., Dec 1981 (Published in Defense Management Journal, Vol. 18, No. 2), AD A 110 220
- PP 326
Roberts, Stephen S., "Western European and NATO Navies, 1981," 27 pp., Jul 1982, AD A118 703
- PP 327
Hammon, Colin, Capt., USN and Graham, David R., Dr., "Estimation and Analysis of Navy Shipbuilding Program Disruption Costs," 12 pp., Mar 1980, AD A112 514
- PP 328
Weinland, Robert G., "Northern Waters: Their Strategic Significance," 27 pp., Dec 1980, AD A112 509
- PP 329
Mangel, Marc, "Applied Mathematicians And Naval Operators," 40 pp., Mar 1982 (Revised), AD A116 598
- PP 330
Lockman, Robert F., "Alternative Approaches to Attrition Management," 30 pp., Jan 1982, AD A112 510
- PP 331
Roberts, Stephen S., "The Turkish Straits and the Soviet Navy in the Mediterranean," 15 pp., Mar 1982 (Published in Navy International)
- PP 332
Jenn, Christopher, "The RDF and Amphibious Warfare," 36 pp., Mar 1982, AD A 113 592
- PP 333
Lee, Lung-Fei and Trost, Robert P., "Estimation of Some Limited Dependent Variable Models with Application to Housing Demand," 26 pp., Jan 1982. (Published in Journal of Econometrics 3 (1978) 357-382), AD A 112 536
- PP 334
Kenny, Lawrence W., Lee, Lung-Fei, Maddala, G. S., and Trost R. P., "Returns to College Education: An Investigation of Self-Selection Bias Based on the Project Talent Data," 15 pp., Jan 1982. (Published in International Economic Review, Vol. 20, No. 3, October 1979), AD A112 480
- PP 335
Lee, Lung-Fei, G.S. Maddala, and R. P. Trost, "Asymptotic Covariance Matrices of Two-Stage Probit and Two-Stage Tobit Methods for Simultaneous Equations Models with Selectivity," 13 pp., Jan 1982. (Published in Econometrica, Vol. 48, No. 2 March, 1980), AD A112 483
- PP 336
O'Neill, Thomas, "Mobility Fuels for the Navy," 13 pp., Jan 1982. (Accepted for publication in Naval Institute Proceedings), AD A112 511
- PP 337
Warner, John T. and Goldberg, Matthew S., "The Influence of Non-Pecuniary Factors on Labor Supply," 23 pp., Dec 1981, AD A113 094
- PP 339
Wilson, Desmond P., "The Persian Gulf and the National Interest," 11 pp., Feb 1982, AD A112 505
- PP 340
Lurie, Philip, Trost, R. P., and Berger, Edward, "A Method for Analyzing Multiple Spell Duration Data," 34 pp., Feb 1982, AD A112 504
- PP 341
Trost, Robert P. and Vogel, Robert C., "Prediction with Pooled Cross-Section and Time-Series Data: Two Case Studies," 6 pp., Feb 1982, AD A112 503
- PP 342
Lee, Lung-Fei, Maddala, G. S., and Trost, R. P., "Testing for Structural Change by D-Methods in Switching Simultaneous Equations Models," 5 pp., Feb 1982, AD A112 482
- PP 343
Goldberg, Matthew S., "Projecting the Navy Enlisted Force Level," 9 pp., Feb 1982, AD A112 484
- PP 344
Fletcher, Jean, W., "Navy Quality of Life and Reenlistment," 13 pp., Nov 1981, AD A113 095
- PP 345
Utgoff, Kathy and Thaler, Dick, "The Economics of Multi Year Contracting," 47 pp., Mar 1982. (Presented at the 1982 Annual Meeting of the Public Choice Society, San Antonio, Texas, March 5-7, 1982), AD A114 732
- PP 346
Rostker, Bernard, "Selective Service and the All-Volunteer Force," 23 pp., Mar 1982, AD A113 096
- PP 347
McConnell, James, W., "A Possible Counterforce Role for the Typhoon," 24 pp., Mar 1982, AD A116 601
- PP 348
Jondrow, James, Trost, Robert, "An Empirical Study of Production Inefficiency in the Presence of Errors-in-The-Variables," 14 pp., Feb 1982, AD A113 591

- PP 349
W. H. Breckenridge, O. Kim Malmin, "Collisional Intra-multiplet Relaxation of $\text{Cd}(5s5p^3P_{0,1,2})$ by Alkane Hydrocarbons," 7 pp., Jul 1981. (Published in Journal of Chemical Physics, 76(4), 15 Feb 1982), AD A113 093
- PP 350
Levin, Marc, "A Method for Increasing the Firepower of Virginia Class Cruisers," 10 pp., Apr 1982. (To be published in U.S. Naval Institute Proceedings), AD A116 602
- PP 351
Coutre, S. E.; Stanford, J. M.; Hovis, J. G.; Stevens, P. W.; Wu, T. T., "Possible Three-Dimensional Backbone Folding Around Antibody Combining Site of Immunoglobulin MOPC 167," 18 pp., Apr 1982. (Published in Journal of Theoretical Biology).
- PP 352
Barfoot, C. Bernard, "Aggregation of Conditional Absorbing Markov Chains," 7 pp., June 1982 (Presented to the Sixth European Meeting on Cybernetics and Systems Research, held at the University of Vienna, Apr 1982.), AD A116 603
- PP 353
Barfoot, C. Bernard, "Some Mathematical Methods for Modeling the Performance of a Distributed Data Base System," 18 pp., June 1982. (Presented to the International Working Conference on Model Realism, held at Bad Honnek, West Germany, Apr 1982.), AD A116 604
- PP 354
Hall, John V., "Why the Short-War Scenario is Wrong for Naval Planning," 6 pp., Jun 1982., AD A118 702
- PP 356
Cylke, Steven; Goldberg, Matthew S.; Hogan, Paul; Mairs, Lee; "Estimation of the Personal Discount Rate: Evidence from Military Reenlistment Decisions," 19 pp., Apr 1982., AD A122 419
- PP 357
Goldberg, Matthew S., "Discrimination, Nepotism, and Long-Run Wage Differentials," 13 pp., Sep 1982. (Published in Quarterly Journal of Economics, May 1982.).
- PP 358
Akst, George, "Evaluating Tactical Command And Control Systems--A Three-Tiered Approach," 12 pp., Sep 1982., AD A122 478
- PP 359
Quester, Aline; Fletcher, Jean; Marcus, Alan; "Veteran Status As A Screening Device: Comment," 26 pp., Aug 1982, AD A123 658
- PP 361
Quanbeck, David B., "Methods for Generating Aircraft Trajectories," 51 pp., Sep 1982., AD A122 386
- PP 362
Horowitz, Stanley A., "Is the Military Budget Out of Balance?," 10 pp., Sep 1982., AD A122 368
- PP 363
Marcus, A. J., "Personnel Substitution and Navy Aviation Readiness," 35 pp., Oct 1982., AD A122 420
- PP 364
Quester, Aline; Nakada, Michael; "The Military's Monopsony Power," 29 pp., Oct 1982., AD A123 657
- PP 365
Greer, William L.; Bartholomew, James C., Cdr.; "Psychological Aspects of Mine Warfare," 15 pp., Oct 1982
- PP 366
Sprull, Nancy L.; Gastwirth, Joseph L.; "On the Estimation of the Correlation Coefficient From Grouped Data," 9 pp., Oct 1982. (Published in the Journal of the American Statistical Association, Sep 1982, Vol. 77, No. 379, Theory and Methods Section.), AD A122 382
- PP 368
Weinland, Robert G., "The Evolution of Soviet Requirements for Naval Forces--Solving the Problems of the Early 1960s," 41 pp., Dec 1982, AD A123 655
- PP 369
Quester, Aline; Lockman, Robert; "The All-Volunteer Force: A Positive Perspective," 29 pp., Nov 1982
- PP 370
Rostker, Bernard D., "Human Resource Models: An Overview," 17 pp., Nov 1982., AD A123 656
- PP 372
Hurley, William J., "An Overview of Acoustic Analysis," 46 pp., Jan 1983
- PP 373
Jacobson, Louis, "Research to Quantify the Effect of Permanent Change of Station Moves on Wives' Wages and Labor Supply," 35 pp., Jan 1983
- PP 374
Clay-Mendez, Deborah and Balls, Ellen, "Balancing Accession and Retention: The Disaggregate Model," 27 pp., Aug 1982
- PP 375
Feldman, Paul, "Privatizing Airports in Washington, D.C.," 17 pp., Feb. 1983
- PP 376
Weiss, Kenneth G., "Power Grows Out of the Barrel of a Gunboat: The U.S. In Sino-Soviet Crises," 136 pp., Dec 1982
- PP 379
Jondrow, James M.; Chase, David E.; Gamble, Christopher L.; "The Price Differential Between Domestic and Imported Steel," 17 pp., May 1983.
- PP 380
Balls, Ellen, "Balancing Accession and Retention: Cost and Productivity Tradeoffs," 38 pp., March 1983.
- PP 381
Reeves, John M. L., "CNA's Conceptual Design and Cost Models for High-Speed Surface Craft," 23 pp., Apr 1983
- PP 382
Levy, Robert A.; Jondrow James M.; "The Adjustment of Employment to Technical Change in the Steel and Auto Industries," 40 pp., May 1983
- PP 383 (Revised)
Thomas, James A., Jr; Mangel, Marc.; "Properties of Quick Look Passive Localization," 39 pp., July 1983

- PP 384
Goldberg, Matthew S. and Hager, Michael F., "A Comparison of the Prophet and ACOL Force Projection Models, " 35 pp., Jun 1981
- PP 385
Angler, Bruce; Driscoll, Kurt and Gredory, David, "Manpower Requirements Derivation for the Navy Comprehensive Compensation and Supply Study," 22 pp., Sep 1982
- PP 386
Angler, Bruce N.; Driscoll, Kurt A.; and Carpenter, Kathy A., "Construction of 'Training Cost Per Graduate' for the Navy Comprehensive Compensation and Supply Study, 67 pp., Nov 1982
- PP 387
Bells, Ellen and Clay-Mendez, Deborah, "Balancing Accession and Retention: The Aggregate Model," 20 pp., Jul 1982
- PP 388
Clay-Mendez, Deborah, "Models of Accession and Retention," 11 pp., Oct 1982
- PP 389
Clay-Mendez, Deborah, "A Minimum Recruiting Cost Function for Male High School Graduates," 31 pp., Jan 1982
- PP 390
Clay-Mendez, Deborah, "Documentation for the Recruiting Cost Estimates Utilized In the Navy Comprehensive Compensation and Supply Study," 30 pp., Sep 1982
- PP 391
Goldberg, Larry, "Summary of Navy Enlisted Supply Study," 11 pp., Jul 1981
- PP 392
Werner, John T. and Simon, Bruce, "An Empirical Analysis of Pay and Navy Enlisted Retention in the AVF: Preliminary Results," 51 pp., Dec 1979



25

END

FILMED

9-83

DTIC